National Aeronautics and Space Administration

# 2016 WILDLAND FIRES

NASA Earth Science
Applied Sciences Program

# *Wildland Fires: 2016 Annual Summary*

**Table of Contents**


| | | |
|---|---|---|
| I. | Introduction | 1 |
| II. | Overview of 2016 | 1 |
| III. | Major Accomplishments | 4 |
| IV. | Program Assessment | 6 |
| V. | Project Portfolio | 8 |
| VI. | Program Management | 13 |
| VII. | Community Leadership | 14 |
| VIII. | International Activities | 18 |
| IX. | Looking Ahead | 19 |
| X. | Appendix | 22 |
| | A. Publications, Presentations, Related Items | |
| | B. Abbreviations and Acronyms | |



**Wildland Fires program management team:**
Lawrence Friedl, Program Manager (*lfriedl@nasa.gov*)
Vince Ambrosia, Associate (*vincent.g.ambrosia@nasa.gov*)
Amber Soja, Associate (*amber.j.soja@nasa.gov*)


**Applied Sciences Program Wildland Fires website:**
http://appliedsciences.nasa.gov/programs/wildfires-program

## I. Introduction

The NASA Earth Science Division's (ESD) Applied Sciences Program promotes efforts to discover and demonstrate innovative, practical, and beneficial uses of Earth-observing environmental satellite data, models, and scientific knowledge. All Program activities support goals to deliver near-term applications of Earth observations, build capabilities to apply Earth science data, and contribute to satellite mission planning.[1] The Program conducts projects in partnership with private and public-sector organizations to inform their decisions and actions; transitioning successful, mature applications to sustain the benefits of Earth science to society.

The Applied Sciences Program's applications themes are currently focused on four of the eight societal benefit areas of the international Group on Earth Observations (GEO): Health (including Air Quality), Disasters, Ecological Forecasting, and Water Resources.[2] In addition, there is a Wildland Fires theme and an initiative on Food Security. The Program includes the impacts from a changing climate within each of these topics.

Fire, especially wildland fire (aka, wildfires), constitutes a crosscutting issue in Earth system science and touches on aspects of many applications areas. From 2002 to 2011, the Applied Sciences Program supported numerous projects and activities related to wildland fire in several applications areas. In 2011, the Program created an element focused specifically on wildland fire, addressing issues from pre-fire through active-fire to post-fire stages. The Wildland Fires program issued a dedicated solicitation in 2011 and selected 17 feasibility studies (Phase I). In 2014, the program selected nine of these studies to continue as full-scale applications projects (Phase II).

## II. Overview of 2016

The past year was a very productive one for the Wildland Fires program, and the projects made significant advancements. Portfolio projects reached major milestones and advanced the use of Earth observations and models to support wildland fire management operations on wildfire events in 2016. Projects and their partners were the subject of press releases and videos and received media attention for their achievements. Wildland fire project-related workshops and training were extremely successful, drawing on expertise from across the program portfolio and the NASA ARSET program.

The year was also a very busy one. In addition to all of the project-focused activities, there were numerous events, conferences, and committees in which the Wildland Fires program management team and projects contributed. In early March 2016, the program

[1] http://isrse37.org/

[2] The eight GEO SBAs are: Disaster Resilience; Food Security and Sustainable Agriculture; Biodiversity and Ecosystem Sustainability; Energy and Mineral Resources Management; Public Health Surveillance; Infrastructure and Transportation Management; Urban Development; and, Water Resources Management.

held its second Wildland Fires team meeting. This meeting helped further interactions across projects and inform partners of the applications and their progress. The attendees explored key issues and challenges faced by wildland fire management practitioners and scientists, and identified research and applications advances that would improve the understanding and management of wildland fires. Held in Boise, Idaho, the meetings included a site visit to the National Interagency Fire Center and discussions with personnel from the various components of the National Interagency Fire Center (NIFC) such as the National Incident Coordination Center (NICC), National Infrared Operations (NIROPS), Smokejumper Base, and Aircraft Operations, among others.

Throughout the year, the Wildland Fires program team and project teams actively participated in symposia, conferences, and workshops. Examples of major events included the 2nd International Smoke Symposium (ISS-2) the ESRI International Users Conference, the EGU Meeting, the International Symposium on Agriculture and Environment, the IUCN World Conservation Congress, and the AGU Fall Meeting.

North America endured a year of contrasts in 2016.[3] On one hand, the acreage consumed and the number of fires nationwide was 92 percent of the 10-year average (67,743 vs. 72,020 fires); acres consumed were 5,509,995 acres (79 percent of 10-year running average of 7,004,259 ac.).[4] On the other hand, there were many large or significant fires, some which set records for size and fire suppression costs. In addition, Canada suffered a mega-fire with the Fort McMurray Fire in Alberta and Saskatchewan, consuming 1.5 million acres; it was the most costly disaster in Canadian history ($3.58B USD).

In the Continental U.S., a few significant fire events affected a broad range of ecosystems and regions: The Anderson Creek Fire in Kansas and Oklahoma burned 367,620 acres, and was the largest wildfire in Kansas's history. In California, the Soberanes Fire (132,127 ac.), was the largest fire in the state in 2016 and was the most expensive firefighting operation in U.S. History ($236M).

In 2016, the Southern Region bore the brunt of the fire season, with 32,696 fires consuming 1,535,942 acres (50 percent of the nation's fires and 28 percent of fire acreage). An extended fall drought across the Southeastern U.S. sparked over thirty large fire events that consumed more than 120,000 acres. The Chimney Tops Fire in Tennessee caused fourteen deaths, and significant loss of homes, businesses, and infrastructure. The Great Basin (761,621 ac.), Rocky Mountain (686,921 ac.), Southwest

[3] https://www.predictiveservices.nifc.gov/intelligence/2016_Statssumm/intro_summary16.pdf
[4] https://www.predictiveservices.nifc.gov/intelligence/2016_Statssumm/2016Stats&Summ.html

(584,620 ac.), California (569,471 ac.; No. and So. Calif. combined), Northwest Region (513,203 ac.), and Alaska Region (496,467 ac.), helped to account for a large percentage of the nationwide acres consumed by wildfires in 2016.[5]

In 2016, some of the project teams assisted in fire suppression and post-fire recovery activities. For example, the RECOVER project team (led by PI Keith Weber, Idaho State University), and the NASA BAER project team (led by PI Mary Ellen Miller, MTRI) supported Canada's Ft. McMurray Fire. Their combined efforts provided short-turn-around data on the burn severity and potential soil erosion in sensitive watersheds and environments in that fire. Keith Weber also assisted in supporting the Pioneer mega-fire in Idaho with NRT RECOVER Decision Support tools. Steve Howard and others supported the Southeast U.S. wildfires with critical fire modeling data during those fires as well.

In 2016, the Applied Sciences Program issued a supplemental solicitation for projects that would develop a socioeconomic assessment of their applications efforts, to coincide with the final year of their project. The Program selected four proposals to pursue impact studies.

At the end of the year, the program management team was actively planning the third Wildland Fires Project Review team meeting for February 28 – March 2, 2017. The meeting will include end users, such as wildland fire management personnel, task leaders, and incident commanders. Wildland Fires Principal Investigator Sher Schranz (Assoc. Director of CIRA), and the NOAA ESRL Labs will co-host the meeting in Boulder, Colorado.

In 2016, the NASA Wildland Fires program continued support to the GEO Global Wildfire Information System (GWIS) initiative. Vince Ambrosia represents NASA on the GWIS element. GWIS is developing a global database and web map service to provide EO-acquired active fire, burned area, and other fire-related information. The international GWIS team matured the wildfire web service and web map capabilities to beta-test status in 2016. In late 2016, NASA released a solicitation (ROSES-16; A.50) that seeks to further develop the GWIS web service, enhance the inclusion of EO data use by the community, and develop training and workshops on using GWIS. Successful proposals will be selected in spring 2017.

On November 19, 2016, NASA launched the first of the NOAA Geostationary Operational Environmental Satellite-R Series (GOES-R) geostationary weather satellites (now named GOES-16).[6] The NOAA GOES-16, with its increased spatial and temporal resolution, and the inclusion of a mid-wavelength thermal infrared band, will improve the early detection and observation of wildfires in the U.S. The wildland fire community is looking

[5] https://www.nifc.gov/nicc/sitreprt.pdf
[6] http://www.goes-r.gov/

forward to the acquisition and testing of wildfire observation capabilities as GOES-16 becomes operational in 2017.

**III. Major Accomplishments**

The Wildland Fires program's nine projects completed their second year as full-scale applications development projects (Phase II) in 2016. They made substantial increases in their ARL levels (see sections below). The project teams were prolific with publications and presentations, and they received coverage of their results in news media, videos, and press releases.

A few projects deserve special recognition for their progress in 2016. The advancements represent emergency support to wildland fire management; maturation of a new EO wildland fire observation capability; a new "catalog request system" for automated access to pre- and post-fire EO data for a specified fire region; simplifying access and modeling with Lidar data to improve vegetation structure information for fire modeling efforts; and development and hosting of workshops with national and international agencies to enable increased use of EO data in wildland fire management scenarios. The following subsections detail those accomplishments:

- Stephen Howard and Joshua Picotte substantially advanced their project in 2016. They used multiple satellite data products (Landsat, AVHRR, GOES, MODIS and VIIRS) to develop the Burned Area Essential Climate Variable (BAECV), which is a fire-scar-similar product that has been used to enhance the Monitoring Trends in Burn Severity (MTBS) products by identifying all the small fire perimeters (< 10 acres) in the full history of Landsat 8 and Landsat 5 data from 1984 through 2015. These data are currently being used by scientists from numerous fields and institutions across the United States. Additionally, the team has worked with its primary partners, USFS RSAC and USGS-EROS, to develop and build a user-friendly, open-source software, stand-alone tool that produces an MTBS-harmonious view, which is compatible in partner organization systems. The beta version of this tool was released in December 2016, and the team expects to have the tool fully operational in many partner organizations in 2017. Furthermore, the team expects to advance the tool to make it globally available by including a larger range of projection options.
- Mary Ellen Miller and team achieved a first step of transitioning the operational use of their spatial WEPP modeling tool. The Cedar Fire (California) BAER teams successfully ran the modeling efforts independent of hands-on support from Mary Ellen and team. This success showcases the work that the team expended on adaptability to easy operations of a complex model by "non-modelers". That accomplishment was achieved after the team organized a two-day WEPP

Modeling Training Workshop in Davis, Calif., entitled: *Landscape Analysis of Soil Erosion Risks and Flood Flows following Wildfire*. The purpose of the workshop was to train BAER teams on the implementation and use of the post-fire EO-enabled, modeling data to improve erosion potential remediation following wildfires.

- Both Keith Weber (RECOVER) and Mary Ellen Miller (NASA BAER project) supported the Incident teams (Canadian Fire Service and others) on the Ft. McMurray Wildfire in Alberta and Saskatchewan. This was the first time that the Canadian and Provincial Fire management agencies have looked to U.S. support to provide rapid post-fire assessment. RECOVER produced a fire-affected vegetation layer, while Mary Ellen Miller and her USFS Co-investigators used those RECOVER data layers to produce a post-fire erosion/storm runoff potential model data set to develop strategies for mitigating soil erosion in variously burned watersheds on the fire. Their support helped to effect post-fire rehabilitation strategies in the city of Ft. McMurray, especially around the city's sewer treatment facility and water supply system, keeping those critical infrastructures operational with safe water/sewer treatment for the residents.
- Wilfrid Schroeder and team coordinated with the USGS to acquire routine, on-demand nighttime Landsat 8 OLI data to be used for wildfire detection and monitoring for the first time for the western U.S. during the summer of 2016. The addition of Landsat nighttime data enhances active fire monitoring systems in the U.S. that currently rely on coarser resolution EO sensors (MODIS, VIIRS, GOES). The improved spatial resolution nighttime active fire data also serves as a "gap-filler" for fire incident management teams, when other nighttime-acquired data (airborne sensor systems) are unavailable.
- Karyn Tabor and the Firecast team dramatically reduced (from hours to minutes) the near-real-time data latency alerts for serving EO wildfire observations from 24-hours to 1-hour with the release of FIRECAST 2.3. Tabor and team also released a fire risk index on the Global Forest Watch Fires, where the Amazon fire risk model was expanded to Indonesia through a partnership with the World Resources Institute Global Forest Watch Fires platform. This capability will dramatically increase the Indonesian government's fire risk capabilities to prevent and mitigate uncontrolled fire spread that creates dangerous air quality conditions, degrades ecosystems, and contributes to global GHG emissions.
- Four of the Wildland Fires Program Phase II projects were selected in 2016 for supplemental support to develop a socioeconomic impact study of their respective project advancements. The projects were required to collaborate with a social- or economic scientist to evaluate the potential benefits their projects make to the wildfire management communities. The one-year project assessments will run concurrent to their Phase II, final year efforts. The socioeconomic projects are further highlighted in Section V.

**IV. Program Assessment**

Overall, the Wildland Fires management team was very pleased with the program and the performance of the project portfolio. The program's advancements were significant and noteworthy.

Through the press coverage, videos, policy impacts, and awards, it was rewarding to see the project teams, partners, and wildfires community recognized for their innovations and achievements. The management team was also pleased by the commitments and contributions of the partner entities, as well as the efforts to leverage new resources to support adaptation of the early applications developments—such as the inclusion of the VIIRS I-band, higher spatial resolution Active Fire Detection data (W. Schroeder, PI) into operational use within the USFS Active Fire Mapping Program.

The year proved to be a very active and productive one in terms of the Wildland Fires program's participation in domestic and international activities. Of special note was the 2nd International Smoke Symposium and its planning committee. Amber Soja served on the International Meeting Planning Committee and was instrumental in the development of the meeting. She served numerous roles as session organizer, session chair, and presenter, and she also developed materials for, and staffed the NASA exhibit booth at the meetings. Vince Ambrosia also staffed the NASA exhibit booth and presented an overview of the Wildland Fires program in a NASA ARSET-led workshop entitled, *Application of Satellite Remote Sensing Data for Fire and Smoke Monitoring*, which was attended by 14 participants from various countries. The ISS-2 attendees responded enthusiastically to NASA's involvement in all facets of the meetings and were very interested in learning about the various aspects of the agency's missions supported fire science efforts.

The number of events and the content addressed reflected the commitment and capabilities in the wildland fire community to connect research and management, and they showed the growing interest in the use of Earth observations. The program management team was very pleased by the participation of the project teams in conferences and workshop trainings.

In 2016, the National Academy of Sciences continued their work on the second Earth Science Decadal Survey, which generates consensus recommendations from the Earth science community about research and applications priorities.[7] The Committee issued its second public request for information in 2016, and we were pleased that several Wildland Fires team members submitted a white paper input. If there is a third call, we will try to encourage an even greater response by the project teams and the broader wildland fire community.

[7] http://sites.nationalacademies.org/DEPS/esas2017/index.htm

On the program's financial front, the commitment of funding for the final year went very smoothly. The majority of projects received their final year of funding in mid-2016 and one project received funding, as planned, in the new fiscal year. Beyond when the funds are *sent* to grantees, NASA Headquarters has been paying ever closer attention to when the funds are spent (a term NASA calls, "costed"). Thus, the program management team will track this more closely in 2017-2018 and will likely engage the project teams more on this topic.

At the 2016 Wildland Fires team meeting in Boise, Idaho, we included a session about socioeconomic impacts, including methods to calculate and quantify the benefits of Earth observations, models, and project activities for improved decision-making. There was a positive response to this topic from the team. We were pleased that four projects expressed interest in an impacts study for their project, and we were very happy with the quality of the brief proposals they submitted for supplemental funding. More information on this is found in Section V.

During 2016, we noted a key, growing hindrance to success of some of our teams and the successful adoption of their application by the partners. Despite strong intentions and commitments by the partner organizations at the transition from Phase I to Phase II, there has been indications on the loss or reprioritization of funding by the partners, which affects their adoption efforts. For instance, the increased costs for active fire suppression has impacted fire management agency commitments to—and investments in—research, research communication, and pre-fire management.

As we enter the final year of the projects, we plan to put significant attention on the transition to and adoption by the partner organizations of the applications or information products. We're pleased that about half of the projects have demonstrated successful operations of their models or capabilities, and have actively participated in "live" demonstrations and support of wildland fire management on various fire incidents.

We will also focus greater attention on lessons learned from the project teams and partners. The lessons will likely cover a range of topics, such as data products and formats, organizational relationships, engagement efforts, methods to achieve applications, training needs and approaches, and unforeseen risks, among others. We began compiling lessons in late 2016, and we will address this topic at our team meetings in 2017.

**V. Project Portfolio**

In 2016, the portfolio contained nine projects, and the projects' foci were evenly split between pre-fire, active-fire, and post-fire applications activities. The projects' institutional leads were from universities (three), federal government (five), and one non-governmental organization. All the projects had partner organizations as co-investigators and collaborators, which included federal and state agencies, interagency work groups, and international collaborations.

Of the nine projects, three have a particular focus on fuels; four address aspects of fire detection, behavior, and forecasting; and, two focus on post-fire remediation. A brief description of each project is below. More information is in the Wildland Fire section of the Applied Sciences Program website.

The majority of projects focused on the use of MODIS, S-NPP VIIRS, and Landsat data and products (and combinations of them). Collectively, projects also used data products from other space-based sensors and satellites including ASTER, AMSR-E, AVHRR, ESA ATSR, MOPITT, CALIPSO, DLR FireBIRD, OMI, GLAS, and SMOS; data from aerial imagery, airborne Lidar scanning, AVIRIS, and UAVSAR; data from community databases, such as MTBS, DEMs and LANDFIRE; and numerous models and model outputs.[8]

*Project Summaries*

The following section describes the nine active Wildland Fires projects and some related activities from 2016:

> ***TOPOFIRE: A System for Monitoring Insect and Climate Induced Impacts on Fire Danger in Complex Terrain; Principal Investigator: Zachary A. Holden, USFS:*** This project integrates NASA remote sensing and climate products into a decision support tool, TOPOFIRE, which delivers a suite of high spatial resolution real-time information sets essential to wildland fire management. The end user/partners community includes the modeling community employing the Wildland Fire Assessment System (WFAS) and the Wildland Fire Decision Support System (WFDSS).
>
> ***Utilization of Multi-Sensor Active Fire Detections to Map Fires in the United States: The Future of Monitoring Trends in Burn Severity; Principal Investigator: Stephen Howard, USGS****:* This project applies NOAA Hazard Mapping System information that includes fire detection data from VIIRS, MODIS, AVHRR, and GOES to identify undocumented small fires to enhance the MTBS mapping process. As part of this project, the team develops user-friendly tools and applications that can be installed locally to support local fire assessments. The

[8] See Abbreviations and Acronyms in Appendix B.

end users and partners include the two major entities that provide the MTBS products for the fire community: USFS RSAC, and USGS-EROS.

***Linking Remote Sensing and Process-based Hydrological Models to Increase Understanding of Wildfire Effects on Watersheds and Improve Post-fire Remediation Efforts; Principal Investigator: Mary Ellen Miller, MTRI:*** This project creates an online spatial database to instantaneously provide end users with the basic tools and data needed to incorporate Earth observations (Landsat *8*, ASTER, MODIS, VIIRS, process-based hydrological models, spatial dry ravel model) into process-based erosion models. Improving accessibility of both modeling capabilities and the required data sets will lead to better assessment tools and support post-fire remediation through erosion modeling. The project focused on supporting end users and partners from the Burned Area Emergency Response (BAER) teams, land managers, and researchers.

***Enhanced Wildland Fire Management Decision Support Using Lidar-infused LANDFIRE Data; Principal Investigator: Birgit Peterson, USGS:*** This project is developing a tool to incorporate Lidar data (ALS and GLAS) and data from the LANDFIRE program. The Creating Hybrid Structure from LANDFIRE/Lidar Combinations (CHISLIC) tool allows users to automatically generate a suite of improved vegetation structure and wildland fuel parameters from Lidar data and infuse these into existing LANDFIRE data sets, ensuring the best data are available to support tactical and strategic wildland fire management decisions. The partner / end-user community involves those that utilize both the Wildland Fire Assessment System (WFAS) and the Wildland Fire Decision Support System (WFDSS) in their assessment tools. For wildfire management and reporting.

In 2016, the team successfully migrated the CHISLIC software tool from using LAStools software suite to using Fusion software suite. This will greatly ease the integration and use of Lidar data with the user community, which can improve the characterization of vegetation structure for pre- and active-wildland fire planning in LANDFIRE datasets. Furthermore, this work has already provided a link to the ICESat-2 Early Adopters program, which will enable a growing constituency of Lidar data users. Lidar data use, as being “simplified” by Brigit and team will have a profound impact on the ease of integration and use of the Lidar data in defining vegetation structural components.

***Wildland Fire Behavior and Risk Forecasting; Principal Investigator: Sher Schranz, Colorado State University:*** This project applies data from MODIS and VIIRS to derive Normalized Difference Vegetation Index (NDVI) and Normalized Difference Water Index (NDWI) maps, and government databases (LANDFIRE and fuel moisture from the network of Remote Automated Weather Stations

(RAWS)) to test the probability of providing forecasting of wildland fire behavior and risk, integrated within the NOAA fire weather forecasting systems. This effort supports decision making by providing integrated local numerical prediction of weather, fuel properties, fire risk, and fire behavior.

In 2016, Schranz team's project effort, the Weather Research and Forecasting - Spread Fire (WRF-SFIRE) model, was a dominant part of the *Workshop on Modeling of Wildfires and Their Environmental Impact* at the International Centre for Theoretical Physics, in Trieste, Italy, June 22-26, 2015. Co-investigators, Jan Mandel and Adam Kochanski gave invited plenary lectures at the meeting. The workshop consisted of hands-on WRF-SFIRE sessions in a computer lab, led by Kochanski. The workshop made it possible for the team to connect with many users and prospective users from developing countries, and train ~50 scientists from developing countries in the installation and use of WRF-SFIRE. The WRF-SFIRE model exposure will lead to a greater chance of adaptation of the efforts into operational use in fire modeling/prediction.

***Development and Application of Spatially Refined Remote Sensing Active Fire Data Sets in Support of Fire Monitoring, Management and Planning; Principal Investigator: Wilfrid Schroeder, University of Maryland***: This project builds on proven science algorithms (fire detection from MODIS) to apply new spatially-refined satellite active-fire detection products from the VIIRS and Landsat 8 sensors that yield significantly improved active fire information. The project team uses these products to initialize and validate fire growth predictions in a coupled weather-fire model, an approach that can be applied to monitor and predict the growth of a fire or a group of simultaneous wildfires in a management unit from first detection until containment. The partners involved include USFS, NWS, and WFDSS.

***An Integrated Forest and Fire Monitoring & Forecasting System for Improved Forest Management in the Tropics; Principal Investigator: Karyn Tabor, Conservation International:*** This project is enhancing a near-real-time alert system (Firecast) that incorporates active-fire identification from VIIRS and MODIS to improve decision making related to forest and fire management in "under-served" communities and better addresses the challenges decision makers face in making timely decisions related to wildland fire management and prevention that have immediate conservation impacts. Specific improvements to Firecast are the inclusion of fire risk warnings and seasonal severity forecasting, as well as an interactive website, email alerts and mobile systems that are explicitly designed based on management request. The partners in this effort include Servicio Nacional de Áreas Naturales Protegidas por el Estado in Peru, the Ministry of Environment and Forests in Madagascar, the Department of

Conservation Areas Wildlife Reserves in Indonesia, and Flora and Fauna International based in the U.K.

The Firecast project team participated in a series of workshops and training on the utility of the Firecast system and Firecast OnSight mobile app training and real-time data provision. The workshops included those in Columbia with an array of federal land management agencies, Firecast OnSight mobile applications training in Madagascar (June 2016), a IUCN World Conservation Congress workshop, the Near-Real-Time (NRT) Workshop in Hampton, Va., and the La Red de Fondos Ambientales de Latinoamérica y el Caribe (RedLAC) Annual Meeting in Brasilia, Brazil.

The team also received the Betty and Gordon Moore Fund-Innovation Funding to install a pilot-study acoustic monitoring sensor network in the Alto Mayo Forest Reserve in Peru monitoring illegal logging in the region. The effort was co-funded through Conservation International/Disney REDD project.

The Firecast team project efforts were also highlighted in the NASA 2017 Spinoff Technology Transfer Program publication (highlighting 2016 activities). The article is entitled "*Earth Observation Spots, Helps Prevent Rainforest Fires*"[9]

***Improving National Shrub and Grass Fuel Maps Using Remotely Sensed Data and Biogeochemical Modeling to Support Fire Risk Assessments; Principal Investigator: James Vogelmann, USGS***: This project is applying Landsat and MODIS data to improve shrub and grassland mapping for fire applications, develop temporally frequent data sets, and therefore determine if improvements in shrub and grassland data layers will alter and improve fire behavior model results. The end user partners include the USFS, Bureau of Land Management (BLM), and Multi-Resolution Land Characteristics Consortium.

***An Automated Burned Area Emergency Response Decision Support System for Post-fire Rehabilitation Management of Savanna Ecosystems in the Western United States; Principal Investigator: Keith T. Weber, Idaho State University***: This project integrates the rapid resource allocation capabilities of cloud computing to automatically collect Earth observations data (Landsat 8, MODIS, AMSR-E (historical, non-operational since Oct 2011), Modern Era Retrospective Analysis for Research and Applications (MERRA), derived decision products, and historic biophysical data for BAER teams to have a comprehensive RECOVER (Rehabilitation Capability Convergence for Ecosystem Recovery) data set in a GIS analysis environment that is customized for the target wildfire, thus reducing the

[9] https://spinoff.nasa.gov/Spinoff2017/ee_5.html

time required to assemble and deliver crucial wildland fire-related data from days to a matter of minutes. The partners include the BLM, Idaho Department of Lands, and BAER teams.

- In 2016, Keith Weber and partners completed a partner webinar, teaching their end-users how to more effectively utilize the capabilities of RECOVER. They also implemented a new tool to allow users to generate their own fire-specific RECOVER DSS websites by leveraging the dedicated RECOVER servers. This "game-changer" capability allows the end-users to fully utilize the RECOVER capabilities with minimal/no support needed by the Weber team. This portends a successful integration of RECOVER into operational use by fire teams and post-fire rehabilitation teams (BAER).
- A team composed of Weber's RECOVER efforts and NASA Goddard Space Flight Center (J. Schnase and M. Carroll) have developed NASA "Wrangler", a capability that automatically acquires Landsat, MODIS, and MERRA data for a given fire and delivers a catalog of pre-fire imagery to the user. This new data set and tool will be available for the 2017 fire season and should also have the ability to automatically collect and deliver post-fire imagery for long-term modeling.

*Project Application Readiness Level Metrics*

At the end of 2016, the portfolio had four projects at ARL 7, one project at ARL 6, three projects at ARL 5, and one project at ARL 4.The mean ARL was 5.9 (compared to 5.1 in 2015) and the mode was ARL 7 (compared to an ARL mode of 4 in 2015). Overall, 76 percent of our projects advanced one or more ARL levels, and we contributed to the Applied Sciences Program meeting its annual performance goal for 2016.

| ***Wildfire Projects*** | |
|---|---|
| *End of 2016* | |
| **ARL** | **Projects** |
| ARL 9 | 0 |
| ARL 8 | 0 |
| ARL 7 | 4 |
| ARL 6 | 1 |
| ARL 5 | 3 |
| ARL 4 | 1 |
| ARL 3 | 0 |
| ARL 2 | 0 |
| ARL 1 | 0 |

*Socioeconomic Impact Assessments*

The Wildland Fires Program selected four projects for a quantitative analysis and valuation (in social and economic terms) of the benefits from the project and the use of Earth observations applications. We provided supplemental funding to these four projects, and the analyses will run concurrently with the final year of the project (with some possible extensions to complete the impact analyses and reporting). The following list the four projects selected and the title of the associated impact study.

- RECOVER, An Automated Burned Area Emergency Response Decision Support System for Post-fire Rehabilitation Management of Savanna Ecosystems
    - *Evaluating the Socioeconomic Impacts of Rapid Assembly and Deployment of Geospatial Data in Wildfire Emergency Response Planning*

- Wildland Fire Behavior and Risk Forecasting; Principal Investigator:
    - *Using Earth Observations to Assess the Socioeconomic Impact of Human Decision Making During the Suppression of a Wildland Fire*

- TOPOFIRE: A System for Monitoring Insect and Climate Induced Impacts on Fire Danger in Complex Terrain
    - *Quantifying Potential Economic Benefits of Incorporating Gridded Fuel Moisture and Weather Data into Wildland Fire Decision Support in the Northern Rocky Mountains*

- Linking Remote Sensing and Process-based Hydrological Models to Increase Understanding of Wildfire Effects on Watersheds and Improve Post-fire Remediation Efforts:
    - *Socioeconomic Impact Analysis of Linking Remote Sensing and Process-Based Hydrological Models to Improve Post-Fire Remediation Efforts*

**VI. Program Management**

In 2016, Vince Ambrosia and Amber Soja continued to support NASA Earth Science as Associate Program Managers for the Wildland Fires program element. They each managed a portfolio of projects; tracking progress, budgets, spending plans, and applications performance. They also further enhanced routine communications with the PIs, project teams, and their partner organizations. Among their activities, the associates discussed projects and program objectives with the project teams, evaluated project progress, assessed ARLs, described expectations, and addressed PI questions and concerns.

*2016 Team Meeting*

The NASA Wildland Fires program held its second project team meeting on March 1-3, 2016. The meeting occurred at the NIFC in Boise, Idaho, in collaboration with the USDA Forest Service. The meeting focused on reviewing the projects' status, informing the partner entities of project advancements and readiness for integration, and enabled cross-project interaction. The event explored key science and applications issues and challenges faced by wildland fire management practitioners and scientists.

The meeting included briefings on the JFSP, ESA SENTINEL data use, the LP-DAAC access, NASA ARSET workshop development, USFS-Pacific Northwest Research Station's Communications and Applications Group, USFS GTAC program updates, USFS HQ Program updates, and the NASA Disasters Program updates. There was also a discussion on socioeconomic impact analysis, including a briefing on the topic from Dr. Eric Lindquist, Boise State University. A full-day site visit to the NIFC included briefings on the major programmatic focus of the center, as well as briefings and tours of the

NICC, the NIROPS Program Office, the NWS Office, the RAWS Office, Smoke Jumpers Operations Base, and the Firefighter Memorial.

*Communications*
In 2016, the Applied Science Program released a new website design, and the Wildland Fires program team provided significant content for the Wildland Fires page.[10] We continued to produce video blogs to convey information about the program to the wildland fires community. NASA News Releases, other articles in the press, and NASA web features related to Wildland Fires projects. For example, the NASA Spinoff publication and the Earth Observatory website featured the Firecast project.[11] [12]

In 2016, the NASA program management team continued to highlight the Wildland Fires program and projects by giving presentations and briefings to the community. We continued to distribute two-page glossy project highlights at numerous conferences and events (see sections VII and VIII). NASA Earth Science included the Wildland Fires program in its exhibit booths at the International Smoke Symposium and the American Geophysical Union's annual Fall Meeting.

The project summaries, press releases, video blogs, reports, outreach and programmatic materials are available via the Wildland Fires page on the Applied Sciences Program website.

## VII. Community Leadership

The Wildland Fires program sponsored and supported numerous community activities in 2016 as part of overall efforts to enhance the use of Earth observations and wildland fire science in fire-related management decisions and actions. The following items summarize leadership of and participation in key interagency committees as well as conferences and symposia.

*The Second International Smoke Symposium (ISS-2)*
The International Association of Wildland Fire in conjunction with National Wildfire Coordinating Group Smoke Committee organized ISS-2 in Long Beach, Calif., on November 14-17, 2016.[13] About 180 people attended and there were about 110 virtual attendees. The symposium served its purpose to convene air quality, fire, and smoke specialists from the research community, non-governmental organizations (NGOs), local/state/federal government agencies and tribes, to discuss the state-of-the-science and state-of-the-applied-science for smoke management and addressing the air quality

[10] http://appliedsciences.nasa.gov/programs/wildfires-program
[11] http://earthobservatory.nasa.gov/IOTD/view.php?id=88530
[12] https://spinoff.nasa.gov/Spinoff2017/ee_5.html
[13] http://www.iawfonline.org/2016SmokeSymposium/index.php

impacts of wildland fire smoke. The ISS-2 successfully brought together researchers from atmospheric sciences, ecological sciences, mathematicians, computer sciences, climatologists, social scientists, health professionals, smoke responders and others to discuss the complex issues of wildland fire smoke and to identify knowledge gaps and opportunities for innovation and development.

The Wildland Fires program sponsored the hybrid-virtual portion of the ISS-2, which provided for in-person and remote access to the symposium. This was particularly poignant considering only 17 of the 60 USDA Forest Service presenters and attendees were approved for travel. This virtual capability was overwhelming successful, allowing remote attendees to present and interact in real time with the presenters and other remote attendees. Program Associate Amber Soja was heavily involved in planning ISS-2, serving on the Steering Committee for the ISS-2, the Sub-committee for Special Issue and Proceedings, and the Virtual Conference Sub-Committee.

In addition, ARSET team members Pawan Gupta and Amber McCullum organized a one-day workshop "*Applications of Satellite Remote Sensing Data for Fire and Smoke Monitoring*" on November 14, at ISS-2. Vince Ambrosia provided an overview presentation on the Wildland Fires program to the workshop participants. There were ~16 workshop attendees, who rated the workshop highly. (See Section VII for additional information about the International Smoke Symposium).

*NASA/USFS Tactical Fire Remote Sensing Advisory Committee (TFRSAC)*
Program Associate Vince Ambrosia continued to serve as a co-chair of the NASA/USFS TFRSAC. The TFRSAC addresses efforts to share information on wildland fire imaging capabilities, technologies and projects that employ space-borne, airborne, and in-situ assets to improve wildland fire characterization capabilities. The community is composed of various federal, state and International organizations such as: CAL FIRE, USFS, BLM, DOI, Canada Forestry Service, etc. Individuals represent Incident managers, Situation Unit Leaders, wildland fire scientists, geospatial specialists, private industry representatives, Defense Department Personnel, University partner, and engineers.

The TFRSAC held its spring 2016 meeting at NASA Ames Research Center, California, on May 24-25, with 45 attendees. The fall 2016 TFRSAC meeting was held in Boise, Idaho (November 3, 2016), with 45 participants. All TFRSAC Meeting presentation materials are made available to the community through the USFS GTAC website.

*Federal Fire Science Coordination Council (FFSCC)*

In June 2016, the Federal Fire Science Coordination Council (FFSCC) held its first meeting.[14] The FFSCC improves the diffusion of fire science and technology, and promotes alignment of scientific capacity with current and future fire science needs. It serves as a formal, institutionalized mechanism that systematically links fire researchers with fire managers to promote articulation of needs by the organizations that rely on fire science and more effective communication pathways on the part of fire-science producers to promote coordination to work on science gaps and identifying opportunities for enhanced fire science access, delivery, and application. In October 2016, the council met to finalize its charter, establish a high level "program of work", identify opportunities for collaboration, and set the course for the future. Program Associate Amber Soja served as the NASA representative on the FFSCC.

*Joint Fire Science Program (JFSP) Fire Science Exchange Network (FSEN)*
Program Associate Amber Soja attended the FSEN annual meeting in Fayetteville, Ark., May 24-26, and presented an overview presentation of the Wildland Fires program, projects, and NASA fire-related satellites and data products. The meeting attracted ~40 attendees, including JFSP management and FSEN representatives from 14 regions. FSEN representatives connect managers, practitioners and scientists working in their regions, demonstrate new knowledge, and provide the best fire information available.[15]

*JFSP FASMEE, NOAA FIREX, and NASA FIREChem*
Program Associate Amber Soja continued to serve as a NASA representative on the inter-agency planning committee for the JFSP *Fire and Smoke Model Evaluation Experiment (*FASMEE)[16], NOAA *Fire Influence on Regional and Global Environments Experiment* (FIREX)[17] and NASA *Fire Impacts on Regional to Global Scales: Emissions, Chemistry, Transport, and Models* (FIREChem)[18]. The FASMEE, FIREX, and FIREChem campaigns are multi-agency field and airborne campaigns expected to be conducted in 2019-2020 in the southeastern and western United States to provide advanced measurements for fire and smoke modeling by conducting high-intensity prescribed fires to produce large developed plumes. The NOAA and NASA airborne campaigns are designed to measure critical biomass burning unknowns, including particulate microphysics, chemical transformations, local air quality, nighttime emissions and long-

[14] A White House report by the Subcommittee on Disaster Reduction's *Wildland Fire Science and Technology Task Force* recommended establishing a standing Federal Wildland Fire Science Coordination Council. The report is available at: https://www.whitehouse.gov/sites/default/files/microsites/ostp/NSTC/sdr_wildfire_st_task_force_final_report.pdf .
[15] http://www.firescience.gov/JFSP_exchanges.cfm
[16] http://www.fasmee.net/ and http://www.firescience.gov/index.cfm
[17] https://www.esrl.noaa.gov/csd/projects/firex/
[18] https://www.esrl.noaa.gov/csd/projects/firex/collaborations.htm

term impacts. A NASA ROSES solicitation is expected for FIREChem in early 2017, and the first experimental burns, are planned for 2019. Please read more in section IX, Looking Ahead.

*IARPC Wildfire Collaboration Team*

The Interagency Arctic Research Policy Committee (IARPC) is charged with enhancing both the scientific monitoring of and research on local, regional, and global environmental issues in the Arctic. IARPC consists of 16 Federal agencies and offices.[19] Program Associate Vince Ambrosia represents NASA on the IARPC's Wildfire Collaboration Team (WCT). The WCT addresses the frequency, extent, and severity of wildland fire in the arctic as a component of understanding high-latitude terrestrial ecosystem process, ecosystem services and climate feedbacks. Ambrosia was the lead author of a report, *Satellite and Airborne Fire Sensor Systems for Arctic Wildfire Observations,* which cataloged and highlighted the orbital and airborne sensor capabilities that are available for observations of wildland fire events or for post-fire assessment in the Arctic (and applicable throughout the globe).[20] The IARPC WCT plans an April 2017 workshop in Fairbanks, Alaska, focused on the use of remote sensing assets to improve arctic and boreal system wildfire observations capabilities and knowledge of available resources.[21]

*American Geophysical Union Fall Meeting*

At the AGU event in December 2016, eleven sessions included wildland fire-related topics. On behalf of the wildland fire community, Vince Ambrosia and Amber Soja gave talks, entitled *NASA and Wildfires: Science and Technology Supporting the Nation*, at the NASA exhibit booth's hyperwall display. The NASA booth included literature on the Wildland Fires program, especially the one-page project summaries.

*American Meteorological Society (AMS)*

The AMS meeting was held in New Orleans in January 2016 and hosted more than 100 fire-related talks. The AMS is unique in that it brings together climatologists and meteorologists that contemplate fire science from a distinctive overarching perspective. On behalf of the wildfires community, several collaborators from our stakeholder communities gave talks, and Amber Soja presented *NASA's Applied Sciences Program: Wildland Fires* at NASA's hyperwall display and exhibitor's booth. Additionally, the NASA exhibit included literature on the Wildland Fires program, which included the glossy project summaries.

*5th International Fire Behavior and Fuels Conference*

[19] http://www.iarpccollaborations.org/index.html
[20] http://www.iarpccollaborations.org/uploads/cms/documents/wildfire-sensor-systems_v5.pdf
[21] https://www.frames.gov/partner-sites/afsc/events/previous-events/workshops/2017-rs-workshop/

The focus of this IAWF–sponsored conference theme was Wicked Problem, New Solution: Our Fire, Our Problem. This event was held concurrently in Portland, Ore., and Melbourne, Australia, April 11-15, 2016. The conference hosted about 800 participants and was attended by a large portion of our project teams and stakeholder communities, which provided opportunities for team interactions and conversations. We drew from the goals and spirit of the event which provided for opportunities to share information about wildland fire behavior and fuels to provide a strong foundation to set a course towards a future that addresses and responds to developing challenges locally, regionally, and globally. Several of our team members presented their work with partners, and Soja represented the program by presenting two talks and one lightning presentation that resulted in dozens of exchanges for NASA data.

**VIII. International Activities**

The Wildland Fires program included a larger number of internationally focused activities in 2016 and increased its activities in a wildland fire task of the intergovernmental GEO. The following summarize participation in key international committees, conferences, workshops, and the GEO task.

*ESRI International Users Conference*

Keith Weber organized and chaired a Wildfire Special Interest Group (SIG) meeting at the 2016 ESRI International Users Conference in San Diego, Calif., on June 29, 2016.[22] The various presenters included information on accessing wildfire EO data and on the RECOVER DSS tool use and operations. Vince Ambrosia presented an overview on the NASA Applied Sciences Program – Wildland Fires directions.

*International Conference on Remote Sensing and Geoinformation of Environment*

Program Associate Ambrosia was a keynote speaker at the Fourth International Conference on Remote Sensing and Geoinformation of Environment *(RSCy-2016)* meeting in April in Paphos, Cyprus.[23] He spoke about the NASA Applied Sciences Program and a focus on applications in wildland fire and disaster remote sensing. He discussed the programmatic directions of the Applied Sciences Program, and he highlighted the importance of partnerships and integration of Earth observations into operational use. He chaired two sessions focused on Disaster Management and also presented a paper on the NASA Wildland Fires program.

*2nd International Smoke Symposium*

Program Associate Amber Soja and Vince Ambrosia represented the Wildland Fires team at the ISS-2 conference in November in Long Beach, Calif. The meeting focused on the challenges faced by the global community as the patterns of wildland fire change under

[22] http://www.esri.com/events

[23] http://www.cyprusremotesensing.com/rscy2016/

the control of weather and climate. One highlight of this symposium was an opening welcome address presented by Lawrence Friedl. Additionally, Soja co-organized two FASMEE/FIREX/FIREChem sessions to bring together the interagency leadership to present program development and show the initial NOAA laboratory results. Soja also presented two papers and moderated two sessions at the ISS-2. A NASA Exhibit booth was included at the ISS-2. V. Ambrosia presented the Applied Science Program – Wildland Fires overview in an ARSET workshop held the day prior to the symposium opening. See Section VII for additional information.

*Group on Earth Observations - Global Wildfire Information System*
The GEO Work Program 2016 included a task entitled the *Global Wildfire Information System (GWIS*), and GEO included GWIS in the 2017-2019 Work Programme.[24, 25] The GWIS initiative provides a platform for harmonized information and enables the coordination of information among major national and regional fire information providers. GWIS relies on collaborative sharing of international EO data systems, as well as national and regional information sources (fire records, etc.). It provides a web-based, gap-filler system for countries and regions that do not maintain a comprehensive wildfire database. For countries and regions where wildland fire information systems exist, GWIS provides a complementary and independent source of harmonized information adding to national and regional information sources. There are four main GWIS elements: Harmonized Fire Information Data Sets; International Networking; Workshop Training; and Cross-Platform Info Sharing at Common Scales. The GWIS seeks to link various national, global and regional systems to make complementary Earth observations data more readily available on wildland fires.

Program Associate Vince Ambrosia continued to serve as the U.S. lead on the GWIS task, helping to identify U.S. interests and priority contributions in the task and GWIS system. The Applied Sciences Program included GWIS in the ROSES-16 A.50 solicitation for proposals to support the GEO Work Programme.

## IX. Looking Ahead

*Wildland Fires Program Team Meeting*
The Wildland Fires program will hold a team review/meeting in March 2017. The meeting will occur in Boulder, Colorado, and is being co-organized with Sher Schranz (CIRA). The meeting will include end users, such as task leaders and incident commanders, to help build connections and ensure the views of managers and practitioners are well represented. The event includes a site visit to NOAA to help the project teams better understand collaborative efforts ongoing at NOAA.

[24] http://www.earthobservations.org/geoss_wp.php
[25] http://www.earthobservations.org/activity.php?id=126

*Earth Science Decadal Survey*

A key item upcoming in late 2017 is the second Earth Science Decadal Survey[26], which is expected to produce its once-a-decade report on Earth science and applications priorities.

*IARPC*

Program Associate Ambrosia will continue as the NASA representative on the IARPC WCT. The WCT, in coordination with the Alaska Fire Science Consortium and the Geographic Information Network of Alaska, will conduct a workshop April 4-6, 2017, at the University of Alaska–Fairbanks. The workshop, entitled *Opportunities to Apply Remote Sensing in Boreal/Arctic Wildfire Management & Science*[27], will convene an international, interdisciplinary community of remote sensing scientists, ecologists, hydrologists, and agency fire managers and decision-makers to develop new opportunities for the use of remotely sensed data. It will identify and simplify access of fire-related EO data in boreal and arctic wildland fire management and science communities. Under the new IARPC Arctic Research Plan 2017-2021, the WCT will be integrated into the IARPC Terrestrial Ecosystems Collaborations Team (TECT).[28]

*GEO GWIS*

The GEO GWIS activities will continue with NASA involvement in the GEO Work Programme 2017-2019. The major elements of that period will be on building capacity in under-served regions for utilizing and feeding information into GWIS, and training uses of the system through regionally oriented workshops and webinars. The program will support the review of GWIS-related proposals to the ROSES-16 A.50 solicitation, and awarded proposals will commence in 2017. Associate Ambrosia will be the POC for this solicitation element.

*FASMEE, FIREEX, and FireChem*

The JFSP-led FASMEE[29], the NOAA-led FIREX[30], and the NASA-led FIREChem campaigns will continue efforts for comprehensive set of ground, airborne, and satellite measurement campaigns to better understand wildland fires, plume dynamics, chemistry and atmospheric compositions from biomass burning. The three campaigns will evaluate the observational data necessary to advance fire and smoke modeling and understanding and improve our understanding of the transport of, and chemical transformations in biomass burning plumes and their impact on air quality to improve air quality forecasting. Program Associates Soja and Ambrosia will continue to

[26] http://sites.nationalacademies.org/DEPS/ESAS2017/index.htm
[27] https://www.frames.gov/partner-sites/afsc/events/previous-events/workshops/2017-rs-workshop/
[28] http://www.iarpccollaborations.org/teams/Terrestrial-Ecosystems
[29] http://www.fasmee.net/ and http://www.firescience.gov/index.cfm
[30] https://www.esrl.noaa.gov/csd/projects/firex/

participate in the planning initiative and link the detailed data collected during this experiment to NASA satellite and airborne resources. This field campaign is unique in the amount of area and fuel burning that is being proposed [four to eight large (>500 ac.) plots in heavy fuels], the realistic burn type (high intensity), and the detailed coincident measurements (e.g., fuel characterization, weather). This type of data collection provides a strategic link to NASA models, aircraft (emissions factors) and satellite data that are not possible to collect during wildland fires. The coordinated campaigns are now planned for 2019-2022.

*Partnership Efforts*

The Wildland Fires program team expects to continue its discussions with USFS GTAC, JFSP, NIFC, and others concerning collaborations and communications on wildland fire science and applications. Program Manager Lawrence Friedl will continue to serve as a Co-Lead of a GEO task on the Sustainable Development Goals, and he will look for opportunities for the program to contribute to the use of Earth observations on wildland fire-related goals. Program Associate Soja will serve on the newly established Federal Fire Science Coordination Council, and Program Associate Ambrosia will continue activities with GWIS, IARPC, TFRSAC, and others.

*ISRSE-37*

In addition, the International Symposium on Remote Sensing of Environment (ISRSE) will hold its biannual meeting in Tshwane, South Africa in May, 2017.[31] There will be several wildland fire-related sessions and the program management team will attend.

[31] http://isrse37.org/

## X. Appendix

### A. Publications

This appendix highlights 2016 peer-reviewed publications, white papers, reports, conference proceedings, presentations, abstracts, workshops, blogs and press releases related to the Applied Sciences Program's Wildland Fires program. Bolded text indicates authors and co-authors that are Principal Investigators, Co-Investigators, and programmatic management staff with the Wildland Fires program element.


Cooke, B, **W.J. Elliot, M.E. Miller, M.** Finney, M. Thompson (2016), Protecting the Source: Tools to Evaluate Fuel Treatment Cost vs. Water Quality Protection. *Science You Can Use Bulletin*, Issue 21. Fort Collins, Colo.: USDA-FS Rocky Mountain Research Station.

**Elliot, W.J., M.E. Miller,** and N. Enstice (2016), Targeting Forest Management Through Fire and Erosion Modeling. *International Journal of Wildland Fire,* No. 25, 876-887. http://dx.doi.org/10.1071/WF15007.

**Kochanski, A. K.**, M. A. Jenkins, K. Yedinak, **J. Mandel**, J. D. Beezley, B. Lamb (2016), Toward an Integrated System for Fire, Smoke, and Air Quality Simulations. *International Journal of Wildland Fire* 25, 534-546.

Koltunov, A., S.L. Ustin, B. Quayle, B. Schwind, **V.G. Ambrosia**, and W. Li (2016), The Development and First Validation of the GOES Early Fire Detection (GOES-EFD) Algorithm, *Remote Sensing of Environment*, Vol. 184, pp. 436-453.

**Miller, M. E. and W.J. Elliot**, (2016), A Rapid Response Database in Support of Post-Fire Hydrological Modeling. *Stream Notes*. February 2016.

**Miller, M. E., W.J. Elliot,** M. Billmire, P.R. Robichaud, K.A. Endsley (2016), Rapid-Response Tools and Datasets for Post-Fire Remediation: Linking Remote Sensing and Process-Based Hydrological Models. *International Journal of Wildland Fire* 25, 1061-1073. http://dx.doi.org/10.1071/WF15162

**Robichaud, P. R., W.J. Elliot**, S.A. Lewis, and **M.E. Miller** (2016), Validation of a Probabilistic Post-Fire Erosion Model. *International Journal of Wildland Fire*, 25(3), 337-350. http://dx.doi.org/10.1071/WF14171

**Schroeder, W**., P. Oliva, L. Giglio, **B. Quayle**, E. Lorenz, and F. Morelli (2016). Active Fire Detection Using Landsat-8/OLI data. *Remote Sensing of Environment*, 185, pp. 210-220.

Vejmelka, M., **A. K. Kochanski**, and **J. Mandel** (2016), Data Assimilation of Dead Fuel Moisture Observations From Remote Automated Weather Stations, *International Journal of Wildland Fire,* 25, 558-568.

**Conference Proceedings / Presentations:**

**Ambrosia, V.G.**, *NASA Applied Science Wildfire Program*. ESRI User Conference, San Diego, Calif., June 29, 2016.

**Ambrosia, V. G. and L. Friedl,** *Keynote Address: NASA Applied Science Program: Building Capacity in the Community*. Fourth International Conference on Remote Sensing and Geoinformation of Environment, Paphos, Cyprus, April 4, 2016.

**Ambrosia, V. G., L. Friedl, and A. Soja,** *NASA Applied Science Program: Wildland Fire and Disasters*. Fourth International Conference on Remote Sensing and Geoinformation of Environment, Paphos, Cyprus, April 6, 2016.

**Coen, J. L**., and **W. Schroeder**, *Data-Driven Forecasting Paradigms for Wildland Fires Using the CAWFE Modeling System and Fire Detection Data*. International Conference on Computational Science, San Diego, Calif., June 6-8, 2016.

**Coen, J.**, *NCAR Climate Workshop. Extremes, Risk, and Attribution Panel*. Fire Attribution: It's complicated. Boulder, Colo., June 30, 2016.

**Coen J., N. Stavros**, J. A. Fites, **D. Schimel**, *Contributions to a Megafire: Fire-Induced Winds, Drought, and Fuel Buildup Due to Fire Suppression*, IAWF 5th International Fire Behavior and Fuels Conference: Wicked Problem, New Solutions: Our Fire, Our Problem, Portland, Ore., April 11-15, 2016.

**Coen J, W. Schroeder**, P. O. Pavon, *Data-driven Forecasting Paradigms for Wildland Fires Using the CAWFE Modeling System and Fire Detection Data*, IAWF 5th International Fire Behavior and Fuels Conference: Wicked Problem, New Solutions: Our Fire, Our Problem**,** Portland, Ore., 11-15 April 2016.

**Coen, J. L., W. Schroeder**, S. Rudlosky, *Transforming Wildfire Detection and Prediction using New and Under-Used Sensor and Data Sources Integrated with Modeling*. InfoSymbiotics DDDAS Conference. Hartford, Conn., Aug 9-12, 2016.

**Elliot, W.J. and M.E. Miller**, *Predicting Landscape-Scale Erosion After Large Wildfires*. 112th Annual Meeting of the Cordilleran Section of the Geological Society of America. April 4, 2016, Ontario, Calif.

**Elliot, W. J., M.E. Miller**, M. Dobre, *Predicting Peak Flows Following Forest Fires*. European Geosciences Union (EGU), Vienna, Austria, April 17-22, 2016.

**Jolly, W. M.,** M. A. Cochrane, P. H. Freeborn, **Z.A. Holden,** T. J. Brown, G. J. Williamson, D. M.J.S.Bowman, *Climate-induced variations in global wildfire danger from 1979 to 2013*, IAWF 5th International Fire Behavior and Fuels Conference: Wicked Problem, New Solutions: Our Fire, Our Problem, Portland, Ore., April 11-15 2016.

**Kochanski, A.K**., M.A. Jenkins, J. Mandel, M. Vejmelka, **S. Schranz**, S. Krueger, C. Clements, B. Davis, D. Seto. *Analysis of Fire-atmosphere Coupling based on FireFlux2 Experimental Data and WRF-SFIRE Simulations,* Proceedings of the 32nd Conference on Agricultural and Forest Meteorology, and 22nd Symposium on Boundary Layers and Turbulence, Salt Lake City, Utah, June 20-24, 2016.

**Kochanski, A.K**., M. A. Jenkins, V. Y. Kondratenko, **J. Mandel**, **S. Schranz**, M. Vejmelka, C. Clements, B. Davis, *Ignition from fire perimeter and assimilation into a coupled fire-atmosphere model*, Proceedings of the 5th International Fire Behavior and Fuels Conference, Portland, Ore., April 11-15, 2016.

**Mandel, J.,** A. Fournier, M. A. Jenkins, **A. K. Kochanski**, **S. Schranz**, M. Vejmelka, *Assimilation of Satellite Active Fires Detection Into a Coupled Weather-Fire Model*, Proceedings for the 5th International Fire Behavior and Fuels Conference, Portland, Ore., April 11-15, 2016.

**Mandel, J.**, L. Cobb, **A. Kochanski**, M. Vejmelka, **S. Schranz**, *Data Assimilation on Random Smooth Functions With Applications to Ensemble Kalman Filter and Satellite Fire Detection*, Data Assimilation and Inverse Problems, University of Warwick, February 23, 2016.

**Mandel, J**., I. Kasanický, **A.K. Kochanski**, **S. Schranz**, and M. Vejmelka, *Assimilation of functional Data and Application to Active Fires Detection From Satellites*, Invited Plenary Lecture--Computational Mathematics in Science and Engineering (CMSE 16), Rožnov pod Radhoštěm, Czech Republic*,* May 26, 2016.

May, J., **K. T. Weber,** K. Serr, **J. Schnase, M. Carroll,** R. Gill, M. Wooten, B. Nicholson, and C. Feldman**.** *RECOVER: Automating Wildfire and Disaster Mapping with ArcGIS and Python*. 2016 ESRI International Users' Conference: Wildfire Special Interest Group Meeting, San Diego, Calif., June 29, 2016.

**Schranz, S., A. Kochanski**, M.A. Jenkins, **J. Mandel,** M. Vejmelka, *Towards an Integrated Fire-Atmosphere Prediction System with Data Assimilation,* 5th International Fire Behavior and Fuels Conference, Portland, Ore., April 11-15, 2016.

**Mandel, J.**, L. Cobb, A. Fournier, I. Kasanický, **A.K. Kochanski**, M. Vejmelka, **S. Schranz**, *Assimilation of Functional Data With Application to a Coupled Fire-Atmosphere Model Driven by Satellite Active Fire Detection,* University of Wyoming, Laramie, Wyo., April 22, 2016.

**Miller, M.E. and W.J. Elliot,** *Rapid Response Tools and Datasets for Hydrological Modeling*. AgroEnviron2016: 10th International Symposium on Agriculture and the Environment. Purdue University West Lafayette, Ind., May 23-27, 2016.

**Miller, M. E.,** L.H. MacDonald, M. Billmire, **W.J. Elliot, P.R. Robichaud,** *Rapid Response Tools and Datasets for Post-fire Hydrological Modeling*. European Geosciences Union (EGU), Abstract No.: EGU 2016-11256; Vienna, Austria, April 17-22, 2016.

**Miller, M.E.,** L.H. MacDonald, **W.J. Elliot**, M. Billmire, S.K. Kampf, **P.R. Robichaud**, S. Schmeer, E. Serocki and M. Dobre, *Rapid Response Tools and Datasets for Post-Fire Hydrological Modeling Applied to the High Park Fire*. 2016 AGU Fall Meeting, San Francisco, Calif., December 12-16, 2016.

**Robichaud, P.R**., **W.J. Elliot**, S.A. Lewis and **M.E. Miller**, *How Well Does the Post-Fire Erosion Risk Management Tool (ERMiT) Really Work?* European Geosciences Union (EGU), Vienna, Austria, April 17-22, 2016.

**Schroeder, W**., and L. Giglio, *MODIS & VIIRS (and Landsat) Active Fire Data*. NASA Direct Readout Conference, Valladolid, Spain, June 21-24, 2016.

**Schroeder, W**., L. Giglio, W. Walsh, et al., *VIIRS (and Landsat-class) Active Fire Data Products*. GOFC-GOLD Fire Implementation Team Meeting, Santiago, Chile, November 15-17, 2016.

**Schroeder, W., Coen, J.**, P. Oliva, B. Quayle, et al., *Satellite Detection and Modeling of Wildfires*. GOFC-GOLD Fire Implementation Team Meeting, Santiago, Chile, November 15-17, 2016.

**Soja, A., V.G. Ambrosia,** and **L. Friedl**, *NASA Fire Science and Applications: Technology, Satellites, Airborne Data and Models*, International Association of Wildland Fire (IAWF): 5th International Fire Behavior and Fuels Conference**,** Portland, Ore., April 11-15, 2016.

**Soja, A., V.G. Ambrosia,** and **L. Friedl** *NASA Fire Science and Applications: Technology, Satellites, Airborne Data and Models***,** Invited Lightning Presentation at IAWF 5th International Fire Behavior and Fuels Conference: Wicked Problem, New Solutions: Our Fire, Our Problem, Portland, Ore., April 11-15, 2016.

**Soja, A., V.G. Ambrosia,** and **L. Friedl**, *NASA Fire Science & Applications: Technology, Satellites and Airborne Data and Models Supporting Earth Science Applications,* International Smoke Symposium, Long Beach, Calif., November 14-17, 2016.

**Soja, A., V.G. Ambrosia,** and **L. Friedl**, *NASA Fire Science & Applications: Technology, Satellites and Airborne Data and Models Supporting Earth Science Applications,* IAWF 5th International Fire Behavior and Fuels Conference: Wicked Problem, New Solutions: Our Fire, Our Problem**,** Portland, Ore., April 11-15, 2016.

**Stavros N. E.**, M. Gunson, **D. S. Schimel,** *Synergistic Use of New NASA Technologies for Pre-, Active-, and Post-Fire Applications*, IAWF 5th International Fire Behavior and Fuels Conference: Wicked Problem, New Solutions: Our Fire, Our Problem, Portland, Ore., April 11-15, 2016.

**Tabor, K.,** *Firecast: A Near Real-Time Satellite Monitoring and Alert System for Improved Forest Management in the Tropics*. IUCN World Conservation Congress, NASA Hyperwall presentation, Honolulu, Hawaii, September 2-4, 2016.

**Tabor, K.,** *From Earth Observation to Earth Action: Satellite Applications for Biodiversity Conservation*. IUCN World Conservation Congress - Learning campus event, Honolulu, Hawaii, September 4, 2016.

**Tabor, K.**, *Monitoring Protected Area Investments With Firecast*. La Red de Fondos Ambientales de Latinoamérica y el Caribe (RedLAC) Annual Meeting, Brasilia, Brazil, November 5th, 2016.

**Weber, K. T**., and J. May, *RECOVER: A Geotechnical Approach.* 2016 Idaho Geospatial Council spring meeting, Boise, Idaho, March 2016.

**Weber, K. T., J. Schnase, M. Carroll,** J. May, R. Howerton, K. Serr, and M. Wooten, *NASA RECOVER: Getting the most out of GIS for Wildfire Decision Support*. 2016 Intermountain GIS Users' Conference, Great Falls, Mont., April 2016.

**Weber, K. T., K. Serr, J. May, J. Schnase, M. Carroll, R. Gill, M. Wooten, B. Nicholson, and C. Feldman.** *The NASA RECOVER DSS*. 2016 ESRI International Users' Conference: Wildfire Special Interest Group Meeting, San Diego, Calif., June 29, 2016.

**Weber, K. T., J. Schnase, M. Carroll,** J. May, C. Feldman, B. Nicholson, K. Serr, R. Gill, and M. Wooten, *RECOVER: Leveraging GIS for Wildfire Decision Support*. Idaho BLM Meeting presentation, Idaho Falls, Idaho, August 2016.

**Press releases / Press stories:**

K. Tabor (Firecast):

**August 9, 2016 - Going High-Tech for Fire Detection**.
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**Webinars / Workshops / Training seminars:**

Webinars:

Addison, P.., A. Kern, R. Coffman, S, Salazar, T. Oomen, and **K. T. Weber.** *Predicting Post-wildfire Debris Flow Occurrence*. NOAA webinar. June 2016 (webinar).

**Weber, K. T.,** and B. Nicholson**.** *Incorporating Debris Flow Models into RECOVER*. US FHWA research webinar. April 2016, (webinar).

**Weber, K. T., J. Schnase, M. Carroll,** J. May, R. Howerton, K. Serr, R. Gill, and M. Wooten**.** *NASA RECOVER: Wildfire Decision Support System***.** RECOVER webinar for partners/end-users. May 24, 2016 (webinar).

**Weber, K. T., J. Schnase, M. Carroll,** J. May, R. Howerton, K. Serr, R. Gill, and M. Wooten**.** NASA RECOVER DSS: Real-time Mapping App. National BAER team monthly webinar meeting. May 25, 2016 (webinar).

Workshops:

**Miller, M.E. and W.J. Elliot**, *Landscape Analysis of Soil Erosion Risks and Flood Flows Following Wildfire*. WEPP Training Workshop, March 22-23, 2016, Davis, Calif.

**Miller, M. E.,** M. Billmire, **W.J. Elliot,** and **P.R. Robichaud,** *Rapid Response Tools and Datasets: Linking Remote Sensing and Process-based Hydrological Models to Support Post-fire Remediation and Fuels Planning*. High Park Fire Post-Fire Science Restoration & Research Workshop. Fort Collins, Colo., November 15, 2016.

**B. Abbreviations and Acronyms**

AGU: American Geophysical Union
AMSR-E: Advanced Microwave Scanning Radiometer-EOS
ARL: Application Readiness Level
ARSET: Applied Remote Sensing Training
ASTER: Advanced Spaceborne Thermal Emission and Reflection Radiometer
ATSR: Along Track Scanning Radiometer
AVHRR: Advanced Very High Resolution Radiometer
AVIRIS: Airborne Visible/Infrared Imaging Spectrometer
BAECV: Burned Area Essential Climate Variable
BAER: Burned Area Emergency Response
BLM: Bureau of Land Management
CAL FIRE: California Department of Forestry and Fire Protection
CALIPSO: Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations
CHISLIC: Creating Hybrid Structure from LANDFIRE/Lidar Combinations
CIRA: Cooperative Institute for Research in the Atmosphere
DEM: Digital Elevation Model or 3-D representation of a terrain's surface
DLR: German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt)
DOI: Department of the Interior
EARSeL: European Association of Remote Sensing Laboratories
EGU: European Geosciences Union
EO: Earth Observations
ESA: European Space Agency
ESD: Earth Science Division
ESRI: Environmental Systems Research Institute
ESRL: Earth System Research Laboratory
FASMEE: Fire and Smoke Model Evaluation Experiment
FIREChem: Fire Impacts on Regional to Global Scales: Emissions, Chemistry, Transport, and Models
FIREX: Fire Influence on Regional and Global Environments Experiment
FFSCC: Federal Fire Science Coordination Council
GEO: Group on Earth Observations
GHG: Greenhouse Gas
GIS: Geographic Information System
GLAS: Geoscience Laser Altimeter System
GOES: Geostationary Operational Environmental Satellite
GOFC-GOLD: Global Observation of Forest and Land Cover Dynamics
GTAC: Geospatial Technology and Applications Center
GWIS: Global Wildfire Information System
IAWF: International Association of Wildland Fire
IARPC: Interagency Arctic Research Policy Committee

ICESat-2: Ice, Cloud, and land Elevation Satellite-2
ISRSE: International Symposium on Remote Sensing of Environment
ISS-2: 2nd International Smoke Symposium
IUCN: International Union for Conservation of Nature
JFSP: Joint Fire Science Program
LANDFIRE: Landscape Fire and Resource Management Planning Tools
Lidar: Light Detection and Ranging
LP-DAAC: Land Processes Distributed Active Archive Center
MERRA: Modern Era Retrospective-Analysis for Research and Applications
MODIS: Moderate Resolution Imaging Spectroradiometer
MOPITT: Measurement of Pollution in the Troposphere
MTBS: Monitoring Trends in Burn Severity
MTRI: Michigan Tech Research Institute
NASA: National Aeronautics and Space Administration
NDVI: Normalized Difference Vegetation Index
NDWI: Normalized Difference Water Index
NICC: National Interagency Coordination Center
NIFC: National Interagency Fire Center
NIROPS: National InfraRed OPerations Group
NOAA: National Oceanic and Atmospheric Administration
NWS: National Weather Service
OLI: Operational Land Imager
OMI: Ozone Monitoring Instrument
PI: Principal Investigator
RAWS: Remote Automated Weather Stations
RECOVER: Rehabilitation Capability Convergence for Ecosystem Recovery
ROSES: Research Opportunities in Space and Earth Sciences
RSAC: Remote Sensing Applications Center
S-NPP: Suomi National Polar-orbiting Partnership
SMOS: Soil Moisture Ocean Salinity
TFRSAC: Tactical Fire Remote Sensing Advisory Committee
UAVSAR: Uninhabited Aerial Vehicle Synthetic Aperture Radar
USFS: United States Forest Service
USGS: United States Geological Survey
USGS-EROS: USGS-Earth Resources Observation and Science
VIIRS: Visible Infrared Imaging Radiometer Suite
WCT: Wildfire Collaboration Team
WEPP: Water Erosion Prediction Project
WFAS: Wildland Fire Assessment System
WFDSS: Wildland Fire Decision Support System
WRF: Weather Research and Forecasting
WRF-SFire: WRF-Spread Fire